This Page Is Inserted by IFW Operations
and is not a part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

B1

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B65H

A2

(11) International Publication Number: WO 96/37427

(43) International Publication Date: 28 November 1996 (28.11.96)

(21) International Application Number: PCT/US96/04782

(22) International Filing Date: 10 April 1996 (10.04.96)

(30) Priority Data:
08/443,082 17 May 1995 (17.05.95) US
08/442,823 17 May 1995 (17.05.95) US

(71) Applicant: MINNESOTA MINING AND MANUFACTURING COMPANY [US/US]; 3M Center, P.O. Box 33427, Saint Paul, MN 55133-3427 (US).

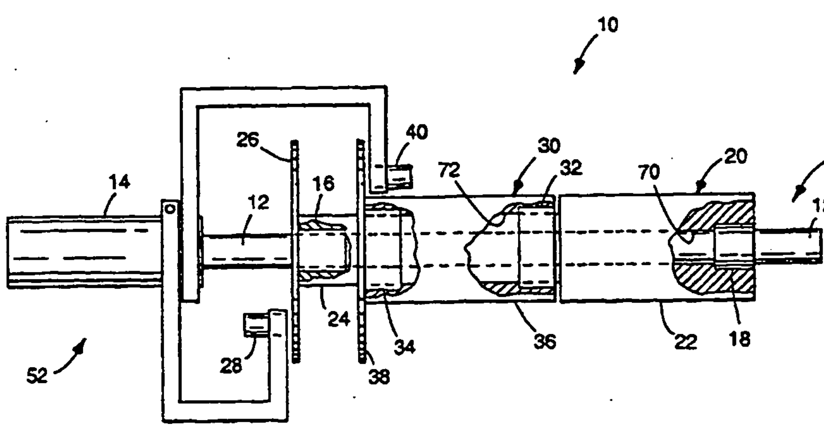
(72) Inventors: RIEDEL, John, E.; P.O. Box 33427, Saint Paul, MN 55133-3427 (US). NIVEN, Clarence, A., Jr.; P.O. Box 33427, Saint Paul, MN 55133-3427 (US). OLSEN, Frederick, O.; P.O. Box 33427, Saint Paul, MN 55133-3427 (US).

(74) Agents: HOFFMAN, Amy, J. et al.; Minnesota Mining and Manufacturing Company, Office of Intellectual Property Counsel, P.O. Box 33427, Saint Paul, MN 55133-3427 (US).

(81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
Without international search report and to be republished upon receipt of that report.

(54) Title: INDEPENDENTLY TENSIONED DUAL UNWIND AND TAKE-UP MECHANISM USING A COMMON SHAFT MOUNTING



(57) Abstract

A mechanism for supporting at least two rolls for an indefinite length web process. The mechanism includes a shaft having a first end and a second end. A first spindle including a mounting portion and a shank portion is rotatably mounted on the shaft such that the mounting portion of the spindle is proximate the second end of the shaft and the shank portion is proximate the first end of the shaft. The first spindle includes a mounting portion and the shank portion. The mounting portion is adapted to telescopically accept and support one of the rolls. Associated with the first spindle and located proximate the first end of the shaft is a brake or motor for controlling the rotation of the first spindle about the shaft. A second spindle is rotatably mounted on the shank portion of the first spindle, preferably with low-friction bearings so that the second spindle may rotate independently apart from the first spindle. Finally, a brake or motor for controlling the rotation of the second spindle about the shank portion of the first spindle is provided and located proximate the first end of the shaft. Such a mechanism allows independent unwinding or winding tension of the materials delivered from or wound on each of the rolls. Additionally, the mechanism allows for the exchange of depleted rolls for full rolls without disassembly of the rotation control means.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgystan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic			SE	Sweden
CG	Congo	KR	Republic of Korea	SG	Singapore
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LR	Liberia	SZ	Swaziland
CS	Czechoslovakia	LT	Lithuania	TD	Chad
CZ	Czech Republic	LU	Luxembourg	TG	Togo
DE	Germany	LV	Latvia	TJ	Tajikistan
DK	Denmark	MC	Monaco	TT	Trinidad and Tobago
EE	Estonia	MD	Republic of Moldova	UA	Ukraine
ES	Spain	MG	Madagascar	UG	Uganda
FI	Finland	ML	Mali	US	United States of America
FR	France	MN	Mongolia	UZ	Uzbekistan
GA	Gabon	MR	Mauritania	VN	Viet Nam

INDEPENDENTLY TENSIONED DUAL UNWIND AND TAKE-UP MECHANISM USING A COMMON SHAFT MOUNTING

Field of the Invention

This invention relates to indefinite length web converting processes. More particularly, the invention relates to dispensing more than one web stock into a converting apparatus at the same point under predictable tensions.

Background of the Invention

A number of industrial processes require performing several steps on an indefinite length sheet or web stock substrate. These processes are typically referred to as converting processes and are commonly used to manufacture adhesive rings, ostomy devices, stickers, tabbing materials, packages, wound dressings, labels and electrodes to name a few. In converting processes, a substrate usually begins in roll form and is fed into the process off of the roll. Once fed into the process, the substrate is subjected to such steps as rotary die cutting, sealing, creasing, and laminating. An example of a converting process used to prepare wound dressings is shown in U.S. Patent No. 4,328,057 issued to Gutow.

Figure 1 of the Gutow patent is similar to Figure 1 herein. Figure 1 illustrates a schematic of creating a laminated substrate and converting the laminate into "windowed pressure sensitive labels." Supply rolls 101 and 103 are fed into the laminating roller 105. Supply roll 101 includes a backing web (also referred to as 101) and supply roll 103 provides a label web (also referred to as 103). The label web 103 is provided with a pressure sensitive adhesive on its underside 107 to allow the laminating roller 105 to laminate the label web 103 and the backing web 101 together, resulting in a laminated substrate 111. After laminating, the laminated substrate is subjected to such converting procedures as printing, which is performed by printing roller 118. The printed laminate is then passed around successive guide rollers 120 and 121.

After the web laminate is printed, it is passed through die cutting roller 122 and anvil roller 123. Gutow discloses that the die cut only extends through the label web of the laminate substrate. Additional converting steps such as removing the window cut in the label web, adding an adhesive and release liner to the laminate substrate, and cutting each individual dressing apart are placed sequentially in the process line after the die cutting operation. If additional layers are required in a particular dressing, the layers are often added sequentially with respect to the other procedures performed during the process.

Two difficulties exist with the above-described procedure. The first is adding layers to the substrate. In order to add layers to the substrate, it is important that the layers are in a particular registration with respect to the cross-web direction of the backing. All layers must also remain wrinkle-free. To date, maintaining the layers in a wrinkle-free condition was in part accomplished by maintaining the web at predictable tensions at certain points during the process. This tension gauging was achieved by either providing a predictable initial tension to the various webs as they were unwound from their supply rolls, for example, by using brakes on the supply rolls to supply an initial tension to the substrates fed into the converting process.

Second, maintaining proper registration and eliminating wrinkles is difficult if it is necessary to add two or more substrate layers at the same point in the process, significant problems with maintaining proper registration and eliminating wrinkles arise. In the process described above, this arises when adding the initial substrates from supply rolls 101 and 103. This is also true if two or more additional substrate layers are added later in the process, and when different unwind tensions are required for the two or more substrate rolls. Varying unwind tensions are necessary if the materials have different thicknesses or different roll diameters so as to require different unwind speeds.

Two methods exist in the art which attempt to overcome these challenges. The first method involves providing two separate axle shafts, each of which supports a supply roll and each of which is equipped with a brake. One of

the two axle shafts is displaced away from the insertion point with proper supports and is supplied with idler rollers to guide the web toward the insertion point. This arrangement has proved unacceptable for a couple of reasons. The structure is quite complicated due to the requirement of providing a remote brace for the displaced axle shaft. It is difficult also to maintain the proper tram of the additional rollers in order to eliminate introduction of wrinkles in the layers.

A second method of adding two or more additional layers to the main web involves placing two supply rolls having separate bearings and separate brakes on the same axle shaft. The brakes are placed on opposite ends of the axle shaft. This arrangement is also undesirable because whenever it is necessary to exchange a full supply roll for a depleted roll, it is necessary to disassemble at least one of the brake assemblies.

Summary of the Invention

This invention provides a mechanism that allows placement of independently tensioned supply rolls on the same axis directly at the point where the supply rolls feed material into a converting process, and which allows for changing of supply rolls without disassembly of tensioning brakes (or drive mechanism or motor).

This invention comprises a shaft having a first end and a second end. A first spindle having a mounting portion, a shank portion, and a means for controlling the rotation of the spindle is rotatably mounted on the shaft such that the mounting portion is proximate the second end of the shaft, the rotation controlling means is proximate the first end of the shaft, and the shank portion is located between the mounting portion and the rotation control means. The mounting portion of the first spindle is adapted to accept a supply roll. A second spindle is rotatably mounted on the shank portion of the first spindle. The second spindle is preferably mounted on low-friction bearings to allow the second spindle to rotate independently from the first spindle. A means for controlling rotation of the second spindle is also included and is located proximate the first end of the shaft. The

second spindle further includes a mounting portion for accepting a supply roll located proximate the shaft portion of the first spindle.

If the mechanism of the present invention is used in an unwind situation, the rotation control means preferably are independently controlled brakes. Such a mechanism makes it possible to apply independent unwinding tensions to material delivered from different supply rolls.

The invention as defined can also provide side-by-side take-up at the end of a converting line. If the invention is used in a take-up capacity, the means for controlling the rotation of the first and second spindles is a pair of independent motors which drive the spindles at predetermined and preferably adjustable torques.

Also provided is a method of independently tensioning two or more webs supplied from two or more rolls of web stock for further processing. A method comprises providing a shaft having a first end and a second end, a first spindle having a mounting portion and a shank portion, and a second spindle; rotatably mounting the first spindle on the shaft with the shank portion proximate the first end of the shaft and the mounting portion proximate the end of the shaft; rotatably mounting the second spindle on the shank portion of the first spindle, mounting a first roll of web stock on the first spindle; mounting a second roll of web stock on the second spindle; feeding the webs from the first and second rolls into converting apparatus; independently controlling rotation of the first and second spindles with a controller located proximate the first end of the shaft to independently control the tension of the webs from the first and second rolls.

Description of the Drawings

FIG. 1 is schematic perspective view illustrating a prior art converting process for preparing wound dressings.

FIG. 2 is a top, partially cut-away view of an exemplary unwind tensioning mechanism according to the present invention.

FIG. 3 is a top view of the present invention with two supply rolls mounted thereon.

FIG. 4 is a cut away schematic view of a partial converting operation using the present invention.

FIG. 5 is a plan view of a bandage.

FIG 6 is a perspective sectional view of the bandage of Figure 5.

FIG 7 is a cross-sectional view of two attached bandages of Figures 6 before slitting to separate the bandages.

FIG 8 is a side view in partial cross section of one machine according to the present invention.

FIG 9 is a view of the machine of Figure 1 taken along the web travel direction.

FIG 10 is an enlarged perspective view of one preferred means for moving the follower gear across the main gear.

FIGS 11A and 11B are schematic diagrams illustrating the concept underlying registration adjustment of machines according to the present invention.

FIG 12 is a schematic representation of a helical main gear according to the present invention.

FIG 13 is a plan view of a bandage produced on a machine according to the present invention.

FIG 14 is a perspective view of the bandage of Figure 6.

FIG 15 is a cross-sectional view of the web used to form bandages according to Figures 13 and 14.

FIG 16 is a web flow diagram of one converting process on a machine according to the present invention.

FIG 17 is an enlarged view of one converting station in Figure 9.

FIG 18 is an enlarged view of a die roll used in converting station depicted in Figure 17.

FIG 19 is an enlarged view of one converting step in the process depicted in Figure 16.

FIG 20 is a view of one preferred unwind stand for use in the converting process depicted in Figures 16 and 19.

FIG 21 is an enlarged view of a sheeting die for use in the converting process of Figure 16.

FIG 22 is a schematic diagram of a machine according to the present invention including a variety of different converting station side plates.

Detailed Description of the Invention

FIG. 2 illustrates a top view of an exemplary unwind tensioning mechanism **10** according to the present invention. The mechanism **10** includes shaft **12** having a first end **52** and a second end **54**. The first end **52** of shaft **12** extends from a mounting **14** adapted for fixing to any support such as a converting machine commonly known in the art which may require side-by-side dispensing from two different rolls. Such rolls are herein referred to as "supply rolls" because they provide a supply of the indefinite length substrate for processing. Shaft **12** is preferably a rigidly fixed shaft.

A first spindle **20** having a longitudinal bore **70** therein receives shaft **12** so as to rotatably mount spindle **20** on roller bearings **16** and **18** on shaft **12**. First spindle **20** includes a mounting portion **22**, and a shank portion **24**. Shank portion **24** of first spindle **20** is mounted proximate the first end **52** of shaft **12**. Mounting portion **22** is mounted on shaft **12** proximate the second end **54** of shaft **12**. Mounting portion **22** is fashioned to accept a supply roll **60** as shown in Figure 3. Mounted at the end of the shank portion **24** of first spindle **20** and proximate the first end **52** of shaft **12** is a first brake disk **26**. Brake disk **26** is adapted to interact with a first brake actuator **28** to provide a variable resistance to rotation of first spindle **20** about shaft **12**. The first brake assembly, comprised of disk **26** and actuator **28**, sets and maintains tension on the web substrate **64** being unwound from supply roll **60**, which is mounted on the mounting portion **22** of first spindle **20**. Figures 2 and 3 show the longitudinal bore **70** in spindle **20** extending throughout the length of spindle **20**, with second end **54** of shaft **12** projecting outward from spindle **20**. Alternatively, the longitudinal bore of the first spindle

may be closed to cover the second end of the shaft. The shank portion of the first spindle is longer than the second spindle.

A second spindle **30** has a central bore **72** therethrough which receives the shank portion **24** of first spindle **20**. The second spindle **30** is rotatably mounted on roller bearings **32** and **34** placed directly on the outer surface of the shank portion **24** of first spindle **20**. The mounting portion **36** of the second spindle **30** is adapted to accept a second supply roll **62** as shown in Figure 3. In a preferred embodiment bearing **32** and **34** are at longitudinal or axial positions between bearings **16** and **18** of first spindle to enhance stability of the mechanism. A second brake disk **38** is mounted on the second spindle **30** proximate the first end **52** of shaft **12**. The second brake disk **38** interacts with a second brake actuator **40** to provide a variably adjustable resistance to rotation of the second spindle **30** about first spindle **20**.

Mounting portion **22** and mounting portion **36** may have equal or unequal outside diameters as suits the intended application.

Both brake assemblies of the invention, **26** and **28**, **38** and **40** are located on the same end of the spindles **20** and **30**. As shown in Figures 2 and 3, both brake assemblies **26** and **28**, **38** and **40** are located proximate the first end **52** of shaft **12**. This arrangement allows an operator to load and unload supply rolls **60** and **62** from mounting portions **22** and **36** off second end **54** of shaft **12** without disturbing brake assemblies **26** and **28**, **38** and **40** or requiring removal of shaft **12** from its mounting. According to the present invention, first and second spindles **20** and **30** are able to freely rotate apart from each other and are separately controlled by the independent brake assemblies allowing each separate brake to exert a different tension on each supply roll. A brake assembly for the first spindle is closer to the first end of the shaft than a brake assembly of a second spindle.

Although Figures 2 and 3 illustrate a mechanism of the invention which includes mountings for two supply rolls, one skilled in the art will recognize that a mechanism is easily constructed according to the invention to include more than two supply roll mountings. One such construction would require fashioning

second spindle 30 similar to first spindle 20 to include both a mounting portion and a shaft portion so that a third spindle could be mounted on the shaft portion of the second spindle. Additionally, a third brake assembly would be provided to supply an independent tension to the web fed off of the third supply roll mounted on the third spindle. One aspect of this invention is that it allows more than one supply roll to rotate about a common axis.

The mechanism of the present invention could also be used in a tensioned take-up capacity at the end of a converting process or other process requiring a tensioned take-up. This could be accomplished by substituting motors for the brake assemblies. Direct drive gears could be placed on shaft **12** in place of brake disks **26** and **38**. Motor gears could actuate the direct drive gears supplying a tensioned wind-up capacity to the present invention. Alternatively, belts or chains placed about spindles **20** and **30** and driven by motors could drive spindles **20** and **30**. It is contemplated that motors commercially available as Gast #4AM-FRV-63A from Midwest Machine Tool Supply of Minneapolis, MN would be suitable for adapting the present invention for independently controlling the wind-up torque when the invention is used in a take-up capacity. Further, in the unwind application in an alternative to brakes, the tension could be regulated against motors which tolerate a slipping action and generate a predicatable torque when so operated.

Figure 4 illustrates a cut away schematic of a converting process. The converting process shown is typical of the type used to prepare bandages. As shown in Figure 4, the present invention is used both in the unwind capacity 7 and in the wind-up capacity **380**. Supply roll **488a** includes a liner substrate (also referred to as **488a**) and supply roll **488b** also provides a liner substrate (also referred to as **488b**). Supply roll **486** also provides a liner substrate (also referred to as **486**). As shown in Figure 4, the present invention allows side-by-side mounting of the supply rolls **488a** and **488b** on the same axis **78** and allows feeding of the liner substrates into the converting process at virtually the same point. Independently controlled disc brakes supply tension to supply rolls **488a** and **488b** to allow exertion of different tensions on each supply roll.

Figures 5 & 6 illustrate a representative bandage **478**. The bandage **478** includes a substrate layer **480**, a layer **482** of pressure-sensitive adhesive and an absorbent pad **484**. The bandage **478** also preferably includes two liners to protect both the adhesive layer **482** and the pad **484** from contamination before use. The bottom liner **488** is provided on one side of the bandage **478** and a top liner **486** is provided on the opposite side of the bandage **478**. The top liner **486** partially overlies the bottom liner **488** to provide the described level of protection for pad **484**.

A preferred method of manufacturing such bandages is in a "two-up" configuration, i.e., two bandages are produced adjacent to each other in the transverse web direction. The bandages are depicted "two-up" cross-section in Figure 7 before being converted by a sheeting die into actual bandages **478**. As a result, a single top liner **486** is provided in the center of the web **490** while two bottom liners **488a** and **488b** (referred to collectively as **488**) are provided on either side of the web **490**. The feeding of these liners **488a**, **488b** and **486** into the converting process is depicted in Figure 4. The cut-away portion of Figure 4 could include many converting operations useful in manufacturing bandages, e.g., sheeting, slitting and laminating to name a few.

The dual wind-up capacity allows winding of scrap substrate onto take-up roller and the winding of the product onto take-up roller **403**. Rollers **401** and **403** are mounted on the same axis **380**. Independently controlled drive motors supply power to rotate the rollers **401** and **403**.

The mechanism and process described herein can also be used with the rotary drum converter described below.

For the purposes of converting wound dressings, the term "substrate" includes but is not limited to films such as polyurethene films, papers, woven or nonwoven webs. If the present invention is used in a converting process other than for manufacturing wound dressings, the term substrate is defined as any indefinite length material used to manufacture the desired end product as known in the art.

As used herein, "proximate" is used as a relative term such that the shank portion of the first spindle is "proximate" the first end of the shaft if it is closer to the first end of the shaft than the mounting portion of the first spindle.

One preferred embodiment of a rotary converting machine useful with the present invention is depicted in Figures 8 & 9. As shown, a central process drum 122 is rigidly mounted on primary axle 148. Axle 148 is rotatably mounted on support 126 as best shown in Figure 8. Helical main gear 144 is also rigidly mounted on the primary axle 148 to ensure that the helical main gear 144 and the process drum 122 rotate in synchrony. A motor in housing 130 rotates pinion 128, which drives main gear 144 which, in turn, rotates process drum 122.

One or more driven nip rolls 132 are optionally provided for applications where it is necessary to convert webs which are elastic and/or delicate. Such materials typically cannot withstand significant amounts of tension at any point in the converting process. Although only one driven roll 132 is depicted upstream from the converting station 134 (process drum 122 rotates counterclockwise in Figure 8), it will be understood that a plurality of driven rolls could be provided around the circumference of process drum 122. In some applications, it may be desirable to locate a driven roll upstream and downstream from each converting station to provide isolation of web tension between converting stations.

Each driven roll 132 preferably is driven by the main gear 44 either through a pinion gear mounted on the roll shaft or through one or more intermediate pinion gears, if necessary. Because the driven rolls are geared to the main gear 144 which rotates in synchrony with the process drum 122, the driven rolls 132 rotate at the same speed as the process drum 122. As a result, tension induced in the web prior to the nip between the driven roll 132 and process drum 122 is isolated from the remainder of the converting process downstream from that

nip point. That isolation improves registration between converting operations performed around the process drum 122.

Furthermore, tension control and web registration is further enhanced by threading the web such that it maintains contact with the process drum 122 after the initial nip formed by the illustrated driven roll 132 until a point after which all of the converting operations have been completed. That threading, i.e., maintaining contact between the web and process drum 122 from an initial point located upstream from the first converting station until an exit point after the last converting station, is preferred. Alternatively, the web can be threaded around tools located in one or more converting stations, particularly where the web is relatively inelastic and/or has a high tensile strength.

In the preferred embodiment of a rotary converting machine according to the present invention, a plurality of converting stations 134 may be mounted about the circumference of the process drum 122, all but one of which have been removed from Figure 8 for clarity. One arrangement of additional converting stations is depicted schematically in Figure 8 as stations A-C, also located about the circumference of process drum 122.

Each converting station 134 could perform any desired converting step including, but not limited to: coating, laminating, die cutting, painting, slitting, sheeting or component placement. The specific tools used in each converting station 134 dictate the converting operation performed at the station. As used in connection with the present invention, it will be understood that "tool" refers to any rolls, coaters, blades, etc. designed to accomplish any desired converting operation.

One skilled in the art will appreciate that not every converting station 134 will perform operations requiring registration with the operations performed by other converting stations located around process drum 122. For example, converting stations which perform slitting or other operations in the web

travel direction do not require registration. Furthermore, the first operation on a web which includes a cross-web component will typically establish the points from which registration of succeeding converting operations will be measured.

For example, a first converting operation may die cut one layer of a multilayer web in a controlled-depth die cut operation. A succeeding converting operation may include a second die cut which must be accurately placed relative to the initial die cuts. It is that second converting station at which the registration apparatus of the present invention will be most useful. As a result, a machine according to the present invention may include a plurality of converting stations, at least one of which is a registrable converting station according to the present invention.

As best seen in Fig. 9, each tool 140a and 140b (referred to collectively as 140) is rigidly attached to a secondary axle (not shown) which is preferably mounted to be substantially parallel to primary axle 148 around which the process drum 122 and helical main gear 144 rotate. In the preferred embodiment, a helical follower gear 152 is rotatably mounted in the converting station 134 to transfer rotary motion of the helical main gear 144 to the tools 140 in the converting station 134.

In the embodiment depicted in Figures 8-10, follower gear 152 is mounted on shaft 150 which allows follower gear 152 to move laterally along shaft 150 while transmitting the rotary motion from helical main gear 144 to the shaft 150. In the preferred embodiment, shaft 150 includes a keyway (not shown) and follower gear 152 includes a key (not shown) which engages the keyway in shaft 150 in a complementary fashion. The keyway and key engage each other such that axial movement of the follower gear 152 along shaft 150 is permitted, but angular rotation of the follower gear 152 relative to the shaft 150 is not permitted. It will be understood that any other mechanism for accomplishing the purpose of allowing

lateral motion while transmitting rotary motion could be substituted for the preferred key/keyway combination.

As best seen in Figure 9, fixed gear 136 is also mounted on shaft 150 but, in contrast to follower gear 152, fixed gear 136 does not move laterally with respect to the tools 140 in converting station 134. Fixed gear 136 transfers rotary motion from the shaft 150 to the tools 140 which are operatively linked to fixed gear 136.

Converting station 134 includes a means for moving the follower gear 152 laterally with respect to helical main gear 144. As best seen in Figures 9 and 10, in the preferred embodiment follower gear 152 is moved axially using a truck 158 which partially surrounds helical follower gear 152. Truck 158 is slidably mounted on rods 160 and 161 and includes a threaded bore therethrough for accepting a threaded shaft 154. By rotating threaded shaft 154 (via turn crank 142 in the preferred embodiment), truck 158 and follower gear 152 can be moved laterally (i.e., in the axial direction) across the threaded shaft 154 and rods 160 and 161. Slide rods 160 and 161 help to maintain proper positioning of truck 158 as it moves horizontally (in a direction substantially parallel to shaft 150 and axle 148).

Although a truck 158 is disclosed as the preferred embodiment for imparting axial motion to follower gear 152, those skilled in the art will appreciate that any means for moving follower gear 152 in the axial direction can be substituted.

That relative lateral movement in the axial direction between the helical main gear 144 and follower gear 152 causes a corresponding change in the relative angular positioning between the follower gear 152 and helical main gear 144 due to the angled orientation of the teeth on main gear 144.

Figures 11A and 11B schematically depict the effect of moving follower gear 152 across the face of main gear 144. In Figure 11A, follower gear

152 and main gear 144 are in one orientation wherein point A on the circumference of follower gear 152 is aligned with a corresponding point A on the circumference of main gear 144. In Figure 11B, the follower gear 152 can be visualized as having been moved into the page, i.e., away from the viewer. As a result point A on the circumference of follower gear 152 is now offset from point A on follower main gear 144. Any rolls driven by follower gear 152 would also be rotationally offset from their original relationship to main gear 144.

By moving follower gear 152 across the face of main gear 144, the relative rotational positions of the two gears can be adjusted. Because main gear 144 rotates in synchrony with the central process drum 122 (and any web threaded over the drum) and follower gear 152 is used to rotate a driven roll in a converting station, the relative angular relationship between the process drum 122 and any roll driven by follower gear 152 is also adjusted by changing the relative angular relationship between the main gear 144 and follower gear 152.

The amount of adjustment available between any main gear 144 and follower gear 152 depends upon the width of the face of the main gear 144 as well as the helix angle of the teeth on that main gear 144. Figure 12 is a schematic representation of a portion of the face of the preferred main gear 144. The axial direction is represented by axis Z while the helix angle is indicated as . The distance R is the circumferential difference traveled by a given gear tooth along the circumference of main gear 144. The distance F is the width of the face of main gear 44. When the helix angle θ and the width of gear face F are known, the distance R can be calculated according to the equation below:

$$R = F(\tan \theta)$$

As a result, the helix angle chosen for the main gear 144 and accompanying follower gear 152 can be chosen to provide the desired amount of registration adjustment. It will be understood that if a greater or lesser amount of

rotational adjustment is required, the width of the gear face and/or the helix angle can be adjusted as required. In one preferred embodiment, the main gear 144 has a 4" (10.1cm) face, follower gear 152 has a 1" (2.54cm) face, and both have a helix angle of 26° relative to the axial direction. It will be understood that any suitable face dimensions and helix angle can be substituted.

As indicated above, the present invention is particularly well suited to convert materials formed using webs which are elastic and/or delicate. Such webs must typically be converted at tension levels which are at or near zero to prevent web breaks and/or puckering due to tension variations in the final product. One product which requires control over tension in the converting process are ACTIVE STRIPS, manufactured by Minnesota Mining and Manufacturing Company, St. Paul, Minnesota. Other examples of webs which exhibit elastic and/or delicate properties are elastic nonwoven tapes such as, for example, those described in U.S. Patent Nos. 4,366,814 and 5,230,701. One skilled in the art of converting will understand that many other web materials which must be converted could be advantageously used with the converting machine according to the present invention.

A representative sample of an ACTIVE STRIP, a self-adhesive bandage, is depicted in Figures 13 and 14. The bandage 178 includes a substrate layer 180 which is elastic. In the preferred embodiment the substrate 180 is manufactured from a microporous foam pressure sensitive adhesive tape marketed under the trademark MICROFOAM by Minnesota Mining and Manufacturing Company of St. Paul, Minnesota. The MICROFOAM backing consists of a controlled density polyvinyl chloride chemically blown foam and the preferred adhesive is an acrylic pressure sensitive adhesive.

Bandage 178 includes a layer 182 of pressure-sensitive adhesive which is, in the most preferred embodiment, bio-compatible. The bandage 178 also

preferably includes an absorbent pad 184 designed to absorb wound exudates such as blood and other fluids. The preferred pads 184 are manufactured from an absorbent fibrous foam or hydrogel pad. Examples of suitable pad materials include gauze and MICROPAD, an absorbent foam pad material marketed by Minnesota Mining and Manufacturing Company of St. Paul, Minnesota. Those skilled in the art will understand that many other absorbent materials could be used to provide pads 184.

The bandage 178 also preferably includes two liners to protect both the adhesive layer 182 as well as pad 184 from contamination before use. The bottom liner 188 is provided on one side of the bandage 178 and a top liner 186 is provided on the opposite side of the bandage 178. The top liner 186 partially overlies the bottom liner 188 to provide the desired level of protection for pad 184. In addition, in some embodiments the bandage 178 can be provided with a bottom liner 188 which includes a J-fold to facilitate liner removal without contacting the pad 184 and such a fold will be well known to those skilled in the art.

As indicated above, the rotary drum converter 120 of the present invention is particularly well-adapted to produce products such as the bandages 178 depicted in Figure 13 and 14. The bandages 178 are preferably produced in a web 190 which is depicted in cross section in Figure 15 before being converted by a sheeting die into the actual bandages 178. The preferred web 190 is formed to produce bandages 178 in a "two-up" configuration, i.e., two bandages are produced adjacent to each other in the transverse web direction. As a result, a single top liner 186 is provided in the center of the web 190 while two bottom liners 188a and 188b (referred to collectively as 188) are provided on either side of the web 190.

As shown in the cross sectional view of Figure 15, the web 190 includes substrate 180 which is elastic, adhesive layer 182 attached to substrate 180 and a pair of pads 184 attached to the adhesive 182. In the center of web 190, top

liner 186 is attached to the adhesive layer 182 as well as lying over at least a portion of pads 184 and each of the bottom liners 188. Two separate bottom liners 188a and 188b are also attached to the outer edges of adhesive 182 and also lie over pads 184 as shown.

Although the cross-sectional view shown in Figure 15 depicts pads 184, it will be understood that at least portions of web 190 do not include pads 184 as there is preferably a space between the edges of pads 184 and the edges of each bandage 178 as best seen in Figure 13.

Figure 16 depicts a thread-up diagram of one embodiment of a rotary drum converter according to the present invention for producing a web 190 as depicted in Figure 15. In accordance with the present invention, all of the converting activities occur around central process drum 122 which is rotating in the direction shown. The converting operations can be separated into three stations indicated as D, E and F located around the circumference of process drum 122.

Converting begins with substrate 180 which is threaded between process drum 122 and nip roll 1100. In the preferred embodiment, nip roll 1100 is driven to ensure that it is rotating at the same speed as process drum 122. In the preferred method, substrate 180 is provided with adhesive 182 and a liner 181. The liner must be removed from adhesive layer 182 to allow the attachment of pads 184 as well as product liners 186 and 188 as described above.

Due to the elastic nature of substrate 180 as described above, removal of the liner 181 is preferably accomplished at converting station D using a knife edge 1102 to isolate the zone in which liner 181 releases from adhesive 182. In the preferred embodiment, liner 181 is threaded through a driven nip formed by rolls 1106 and 1104, one of which is preferably an elastomeric roll and the other of which is preferably knurled to provide a positive grip on liner 181. It is preferred that one of nip rolls 1104 or 1106 is driven ultimately by main gear 144 to match

the speed of the liner 181 with the speed of web 80. As a result, removal of liner 181 does not induce tension into substrate 80 which would be highly undesirable. The liner 181 is collected on a rewind as shown in Figure 16.

The actual implementation of knife edge 1102 and nip rolls 1104 and 1106 will be well known to those skilled in the art and will not be described in detail herein.

At the next converting station, i.e., Station E, the material for pads 184 is provided and attached to the adhesive surface 182 on substrate 180. That process is accomplished through the use of a three roll stack using rolls 1108, 1110 and 1112.

Roll 1108 is preferably an elastomeric roll which pulls the web 183 from its unwind through the nip formed by roll 1108 and anvil roll 1110. Anvil roll 1110 forms a nip with roll 1108 and also preferably acts as a surface against which die roll 1112 acts to cut pads 184 from two webs 183 which provide the material for pads 184. In the preferred embodiment, two rows of pads 184 are placed on web 180 to form the "two-up" bandages described above. To reduce waste it is preferable to supply two webs 183, each of which is used to form one row of pads 184.

In the preferred embodiment both anvil roll 1110 and die roll 1112 are driven from main gear 144 according to the principles of the present invention. As a result, their speed is precisely matched with the speed of the central process drum 122.

Figure 17 depicts an enlarged view of the converting station E depicted in Figure 17. As shown there a guide 1113 is located between anvil roll 1110 die roll 1112 and central process drum 122. The guide 1113 is formed to guide the movement of the individual pads 184 after they have been removed from the web 183 and before they have been applied to the adhesive on substrate 180.

Guide 1113 does so because its shape matches the radius of the die roll 1112 to help retain pads 184 in die cavities 1111 on die roll 1112 (die cavities are not depicted in Figure 17 for clarity, refer to Figure 18) after they have been formed from webs 83.

The die cavities 1111 shown in Figure 18 are preferably lined with a resilient material to assist in transferring pads 184 to the adhesive on substrate 180. The resilient material also ensures that pads 184 release from die cavities 1111 and die roll 1112. Alternate methods of forming and/or placing pads 184 will be well known to those skilled in the art. Examples include using a vacuum system within cavities 1111 to retain the cut pads 184 until placement, or a pick and place apparatus could be used to place pre-formed pads 184 on the substrate 180.

The portions of webs 183 remaining after the pads 184 have been removed are indicated by reference number 185 and are commonly referred to as weeds. The weeds 185 are preferably collected on a rewind stand as shown in Figure 16 and are later recycled or discarded.

In the most preferred embodiment, the action of converting station E in forming pads 184 is preferably discrete as opposed to continuous. Those skilled in the art will understand the use of clutch mechanisms which advance webs 183 as needed to apply pads 184 at spaced locations along a substrate 180. In such a process, the amount of weed material 185 can be reduced because no material would remain between adjacent pads 184 (in the web travel direction) if this mechanism were used, i.e., the web 183 would advance in discrete steps equal to the length of a pad 184 in the web travel direction.

Turning now to Figure 19, the thread-up for the top liner 186 and bottom liners 188a and 188b is shown as enlarged from the view seen in Figure 16. Substrate 180 is located on process drum 122 (it will be understood with adhesive sides 182 out) and rotating in the direction shown. Substrate 180 includes pads 184

attached to adhesive surface 182 as described above at Station D. Bottom liners 188a and 188b and top liner 186 are threaded between a nip roll 1114 and process drum 122 where they contact the adhesive 182 on substrate 180. By applying pressure at that nip, the webs are joined together to form web 190 as depicted in the cross-sectional view of Figure 15.

Nip roll 1114 is preferably a resilient roll, such as a silicone rubber, having an appropriate durometer. The actual choice of roll material and, if an elastomer, the durometer, will be well known to those skilled in the art.

In the preferred embodiment, nip roll 1114 is preferably driven by a series of gears which are ultimately driven by main gear 144 in accordance with the principles according to the present invention. As a result, the speed of nip roll 196 precisely matches the speed of process drum 122, thereby preventing overdriving or underdriving of nip roll 1114 which could induce tension into the web 190.

Returning now to Figure 16, top and bottom liners 186 and 188a and 188b are threaded between a driven nip roll 1114 and central process drum 122. To further prevent tension in the substrate 180, bottom liners 188a and 188b are preferably unwound from an unwind stand which allows for independent rotation of each of rolls 188a and 188b.

A schematic diagram of one preferred unwind stand is depicted in Figure 20 and includes a shaft 1130 which includes two sections 1132 and 1134 each of which rotate independently. Section 1132 is mounted for rotation on an axle and includes a shank portion (not shown) on which section 1134 is mounted for independent rotation. The rotation of each section 1132 and 1134 is operatively connected to a separate braking unit which independently controls tension of each of the webs 188a and 188b.

After top and bottom liners 186 and 188 have been added to web 1190 the web is threaded between a nip formed between a sheeting die 1116 and central process drum 122. In the preferred embodiment, sheeting die 1116 includes a two-up die cavity design which includes die cavities 1117 as shown in Figure 21. The actual spacing of cavities 1117 should be matched with the spacing between cavities 1111 and die roll 1112 used to form and place pads 184 in web 190.

In addition to the tension control useful for converting a product from an elastic substrate such as that described above, the registration control abilities of the present invention are also particularly useful when converting bandage type products as described herein. The registration between die cavities 1117 on sheeting die 1116 with die cavities 1111 on die roll 1112 is essential to produce bandages 178 as described in Figures 13 and 14. Pad 184 must be centered in the bandage 178 and, as a result, sheeting die 1116 must be registered with respect to the placement of pads 184 to achieve that result. In the preferred embodiment, sheeting die 1116 is driven from main gear 44 using a follower gear 152 as described above to achieve that registration. It will be understood, however, that either sheeting die 1116 or pad die 1111 could be capable of registration adjustment in accordance with the principles of the present invention.

In the preferred process an additional nip roll 1118 is provided to form a nip with central process drum 122 to isolate tension from the rewind stand 189 which rewinds the weed from the sheeting process performed using sheeting die 1116. It is preferred that nip roll 1118 is driven to ensure precise speed control to prevent inducing tension into web 190. In some instances, it is also helpful to separate bandages 178 from the weed by wrapping the weed around a relatively small diameter roll.

In one preferred process bandages 178 are then collected in bin 1122 using sheet 1120 as shown. It is also envisioned that bandages 178 may be introduced directly into a packaging system in line with the converting machine to further enhance production of bandages 178 using a machine according to the present invention. The integration of such equipment will be well known to those skilled in the art and will not be described herein.

Figure 22 is a schematic diagram depicting a variety of side plates used in converting stations which can be attached to a rotary drum converter 122 according to the present invention. Station G includes side plates which are particularly adapted for converting stations in which a die roll will be acting against a separate anvil roll as opposed to the central process drum.

Side plates 1150 include slots 1152 and 1154 for accepting blocks on which the desired rolls are mounted. It is preferred that one of the slots 1152 be oriented substantially radially with respect to the central process drum while the other slot 1154 is located at an angle to a radial line extending from the central process drum. As a result, as rolls are advanced within each of slots 1152 and 1154 they will meet, thereby forming a desired nip point between, for example, an anvil roll and a die roll. One example of a station such as this is depicted as station E in Figure 16 where it is used to provide the die cutting process for forming pads 184 on bandages 178. In that example anvil roll 1110 and die roll 1112 are mounted in side plates similar to 1150 to provide the desired nip between anvil roll 1110 and die roll 1112.

Converting station H is an example of a "single" converting station in which a single slot 1162 is provided along with a single gear 138 which is driven ultimately from the main gear 144. As a result, a roll mounted in side plate 1160 can be driven from main gear 144 to provide both speed and registration control as described above.

Converting station I is provided with a side plate 1170 which includes two slots 1172 and 1174 for receiving rolls both of which are driven off a single gear 138g. Because both rolls mounted in slots 1172 and 1174 will be driven by a single gear 138g, it will be understood that no registration control can be achieved between those two rolls. Rather, as described above, registration is achieved between stations which operate on separate gears 138 which are attached to separate follower gears 152 along the lines discussed above.

The converting stations described in Figure 22 are only a few examples of converting stations which can be used around a central process drum 122 in accordance with the principles of the present invention and the invention should not limited to the specific examples described herein.

We Claim:

1. A mechanism for supporting at least two rolls of indefinite length substrate, comprising:

a shaft having a first end and a second end;

a first spindle, comprising a mounting portion and a shank portion, said mounting portion adapted to support a roll of indefinite length substrate, said first spindle being rotatably mounted on said shaft such that said mounting portion is proximate said second end of said shaft and said shank portion is proximate said first end of said shaft;

means for controlling the rotation of said first spindle about said shaft, said rotation controlling means being located proximate said first end of said shaft;

a second spindle adapted to support a roll of indefinite length substrate rotatably mounted on said shank portion of said first spindle; and

means for controlling the rotation of said second spindle about said shank portion, said second spindle rotation controlling means being located proximate said first end of said shaft.

2. The mechanism of claim 1 wherein said means for controlling the rotation of said first spindle and said means for controlling the rotation of said second spindle each comprise an independently controlled brake.

3. The mechanism of claim 2 wherein said brake comprises a disc brake assembly.

4. The mechanism of claim 1 wherein said means for controlling the rotation of said first spindle and said means for controlling the rotation of said second spindle each comprise a motor adapted to independently apply torque to said first and said second spindles.

5. The mechanism of claim 1 wherein the first end of the shaft is mounted to a support.

6. A mechanism for supporting at least two rolls of indefinite length substrate, comprising:

a shaft having a first end and a second end;

a first spindle, comprising a mounting portion and a shank portion, said mounting portion adapted to support a roll of indefinite length substrate, said first spindle being rotatably mounted on said shaft such that said mounting portion is proximate said second end of said shaft and said shank portion is proximate said first end of said shaft;

a brake assembly to control rotation of said first spindle about said shaft, said brake assembly being located proximate said first end of said shaft;

a second spindle adapted to support a roll of indefinite length substrate rotatably mounted on said shank portion of said first spindle; and

a brake assembly controlling the rotation of said second spindle about said shank portion, said second brake assembly located proximate said first end of said shaft.

7. The mechanism of claim 6 wherein said brake assembly comprises a disc brake assembly.

8. The mechanism of claim 6 wherein the first end of the shaft is mounted to a support.

9. A method of manufacturing wound dressings, comprising:

supporting at least two rolls of indefinite length substrate on a mechanism, the mechanism comprising a shaft having a first end and a second end;

a first spindle, comprising:

a mounting portion and a shank portion, said mounting portion adapted to support a roll, said first spindle rotatably mounted on said shaft such that said mounting portion is proximate said second end of said shaft and said shank portion is proximate said first end of said shaft;

controlling the rotation of said first spindle about said shaft with a first rotation controlling means, said rotation controlling means located proximate said first end of said shaft;

a second spindle adapted to support a roll rotatably mounted on said shank portion of said first spindle; and

controlling the rotation of said second spindle about said shank portion with a second rotation controlling means, said second spindle rotation controlling means located proximate said first end of said shaft;

feeding said substrates into a converting operation which includes laminating and die cutting said substrate.

10. The method of claim 6 wherein said substrates comprise a film coated with an adhesive and a label stock.

11. The method of claim 6 wherein said step of controlling rotation of said first and second spindles comprises independently controlling brakes to resist rotation of the first and second spindles.

12. A method of independently tensioning two or more webs supplied from two or more rolls of web stock for further processing, the method comprising:

providing a shaft having a first end and a second end, a first spindle having a mounting portion and a shank portion, and a second spindle;

rotatably mounting the first spindle on the shaft with the shank portion proximate the first end of the shaft and the mounting portion proximate the second end of the shaft;

rotatably mounting the second spindle on the shank portion of the first spindle;

mounting a first roll of web stock on the first spindle;

mounting a second roll of web stock on the second spindle;

feeding the webs from the first and second rolls into converting apparatus;

independently controlling rotation of the first and second spindles with a controller located proximate the first end of the shaft to independently control the tension of the webs fed from the first and second rolls.

13. A method according to claim 9 further comprising removing the first and second rolls of web stock from the first and second spindles without moving the controller.

14. A method according to claim 10 wherein the controller comprises a first brake assembly adjacent the first end of the shaft, the first brake assembly being operatively connected to the shank portion of the first spindle, and a second brake assembly adjacent the first end of the shaft, the second brake assembly being operatively connected to the second spindle; the step of independently controlling rotation of the first and second spindles with a controller located proximate the first end of the shaft to independently control the tension of the webs fed from the first and second rolls comprising:

independently actuating the first and second brake assemblies to independently resist rotation of the first and second spindles.

15. A method according to claim 10 wherein the step of independently controlling rotation of the first and second spindles with a controller located proximate the first end of the shaft to independently control the tension of the webs feed from the first and second rolls comprising:

independently driving the first and second spindles with a motor.

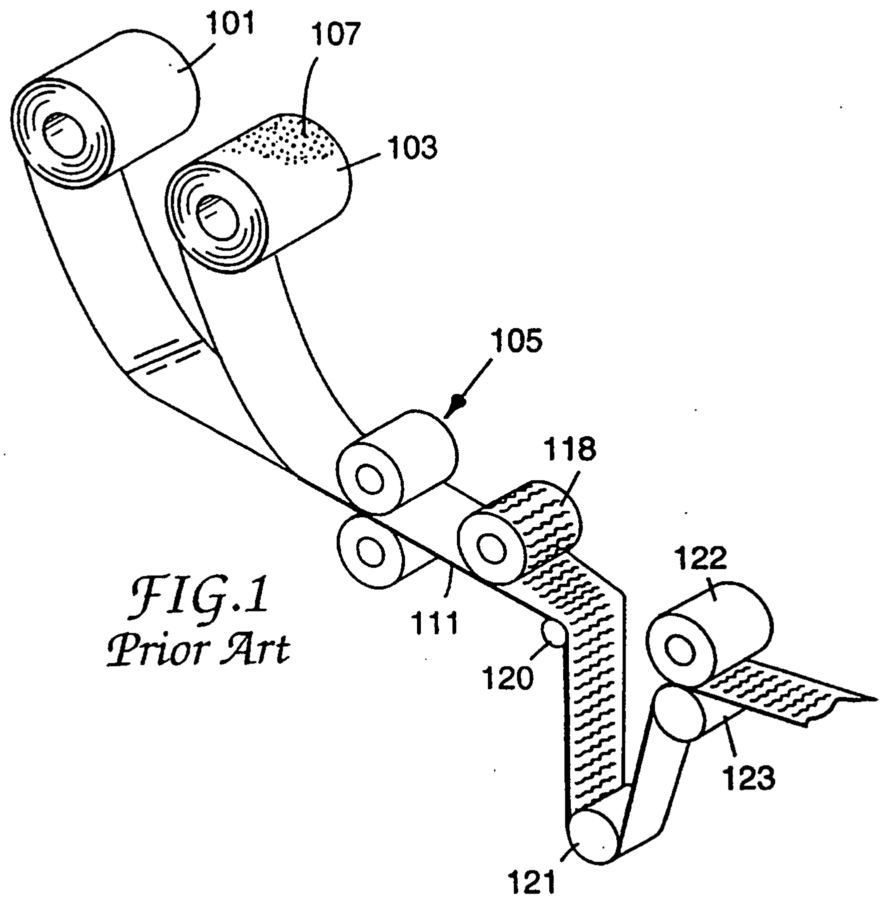


FIG.1
Prior Art

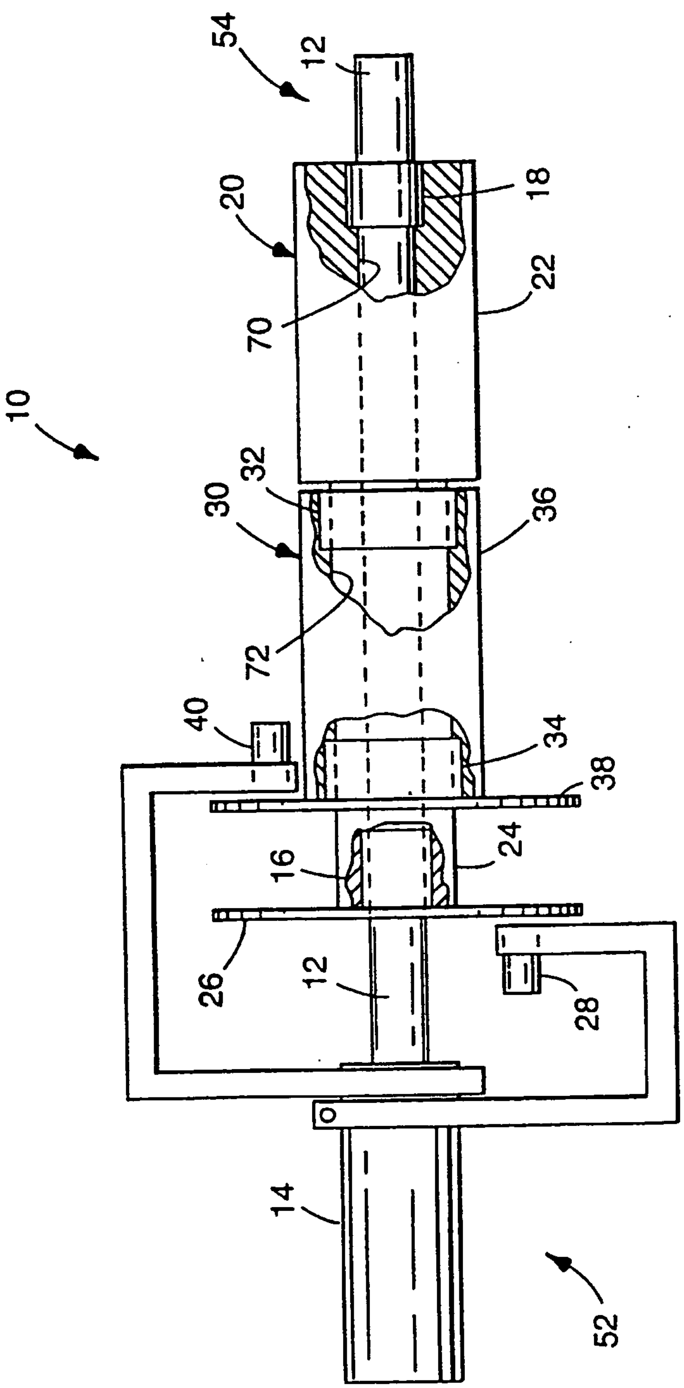


FIG.2

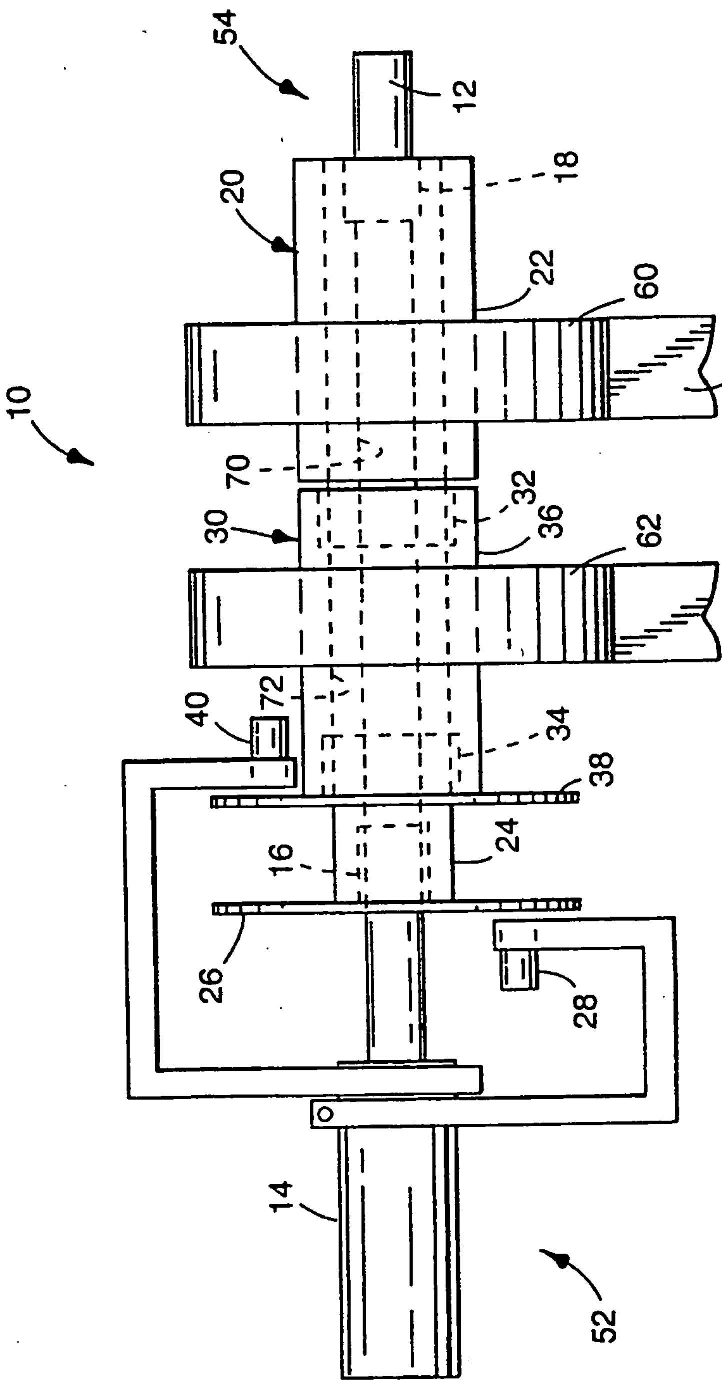


FIG.3

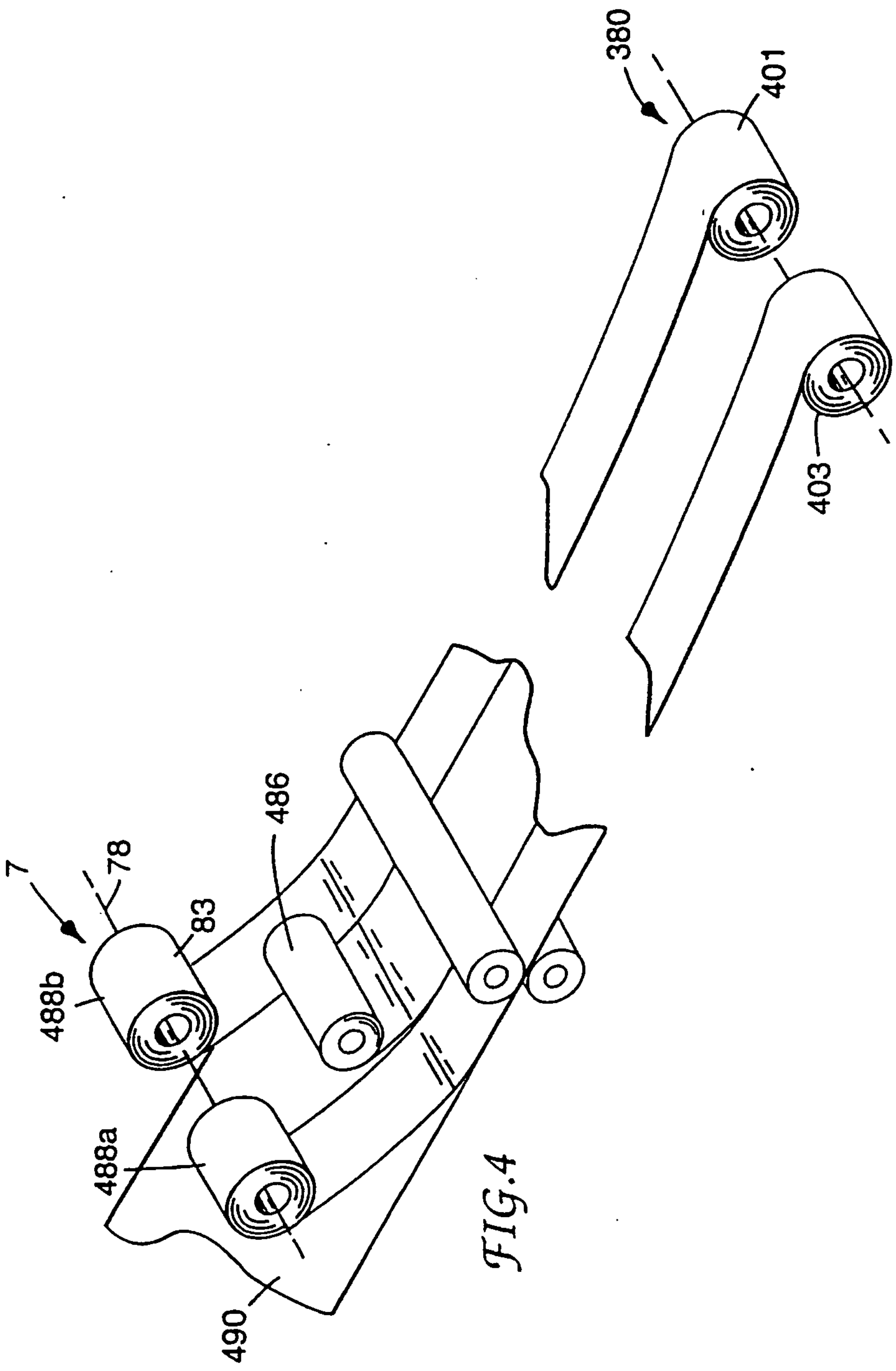


FIG.4

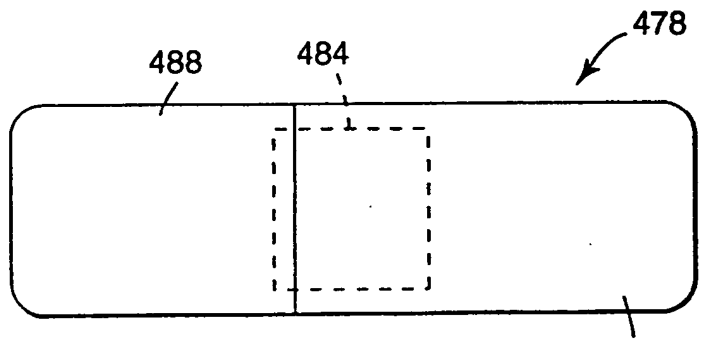


FIG.5

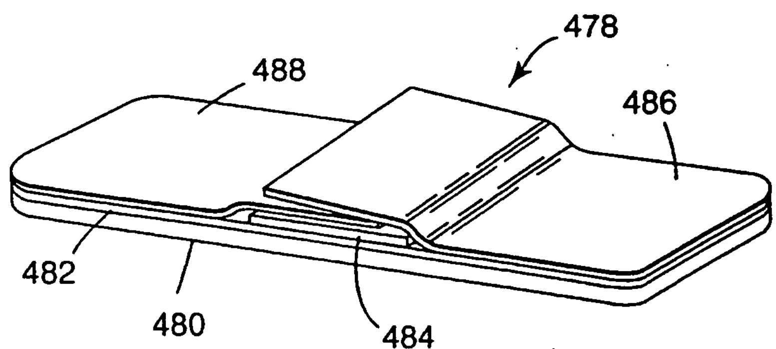


FIG.6

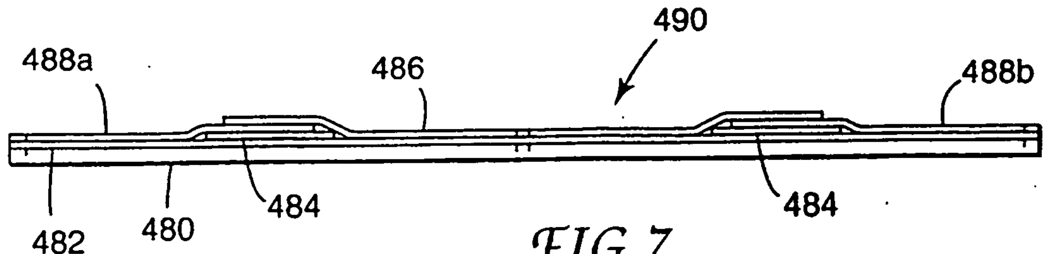


FIG.7

FIG. 9

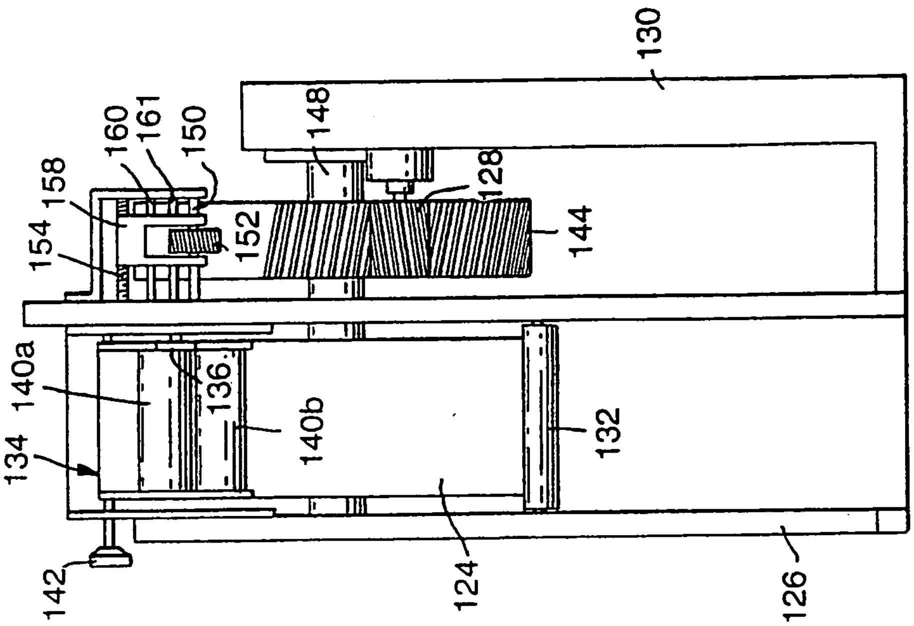
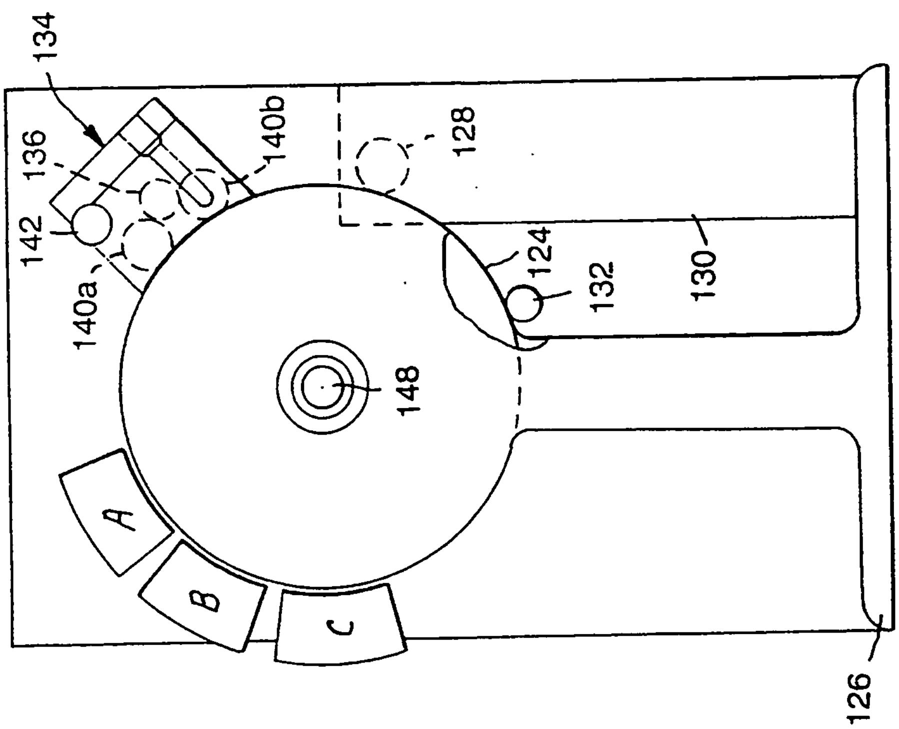

130
148
160
161
150
158
128
154
152
144
140a
136
134
140b
132
142
124
126

FIG. 8


134
136
140b
128
142
124
132
130
140a
148
A
B
C
126

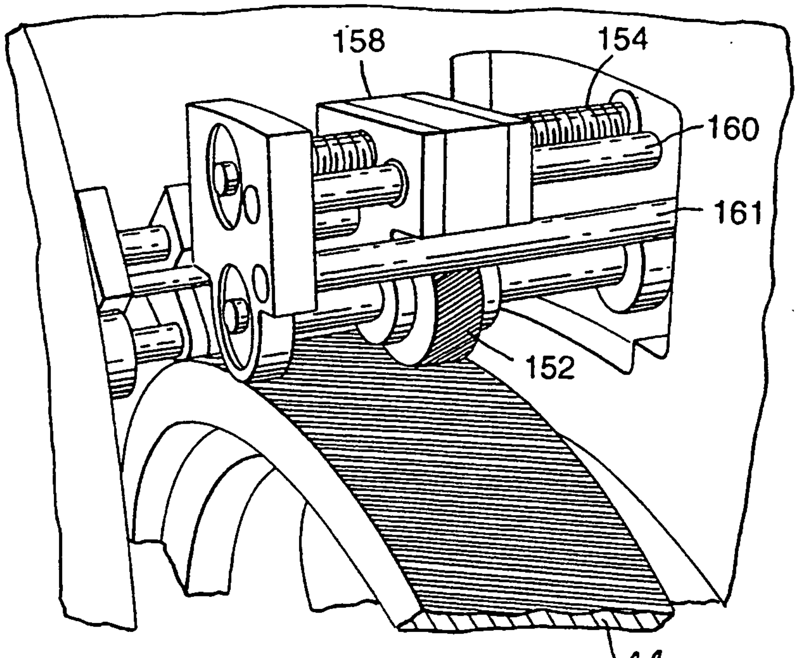

158
154
160
161
152
44

FIG. 10

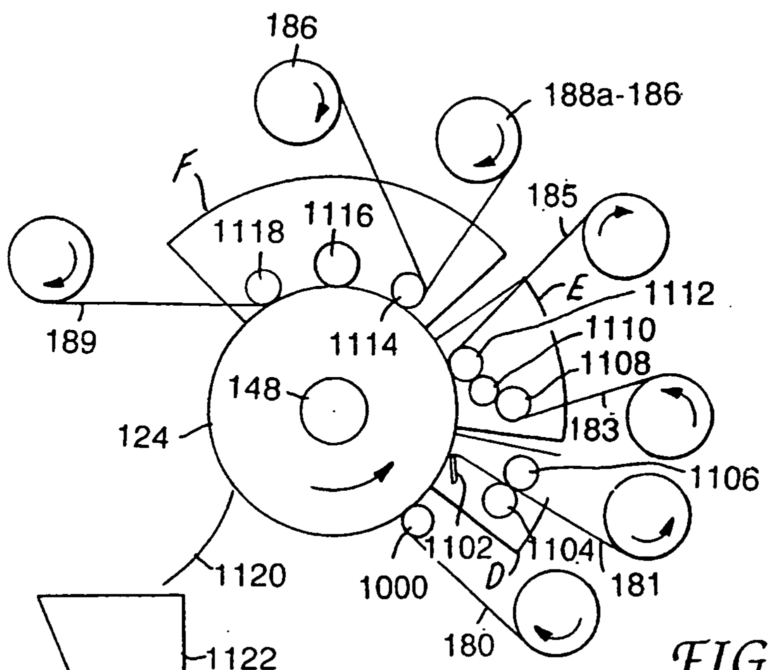

186
188a-186
F
185
1118
1116
E
1112
189
1114
1110
1108
148
183
124
1106
1102
1104
181
1120
D
1000
180
1122

FIG. 16

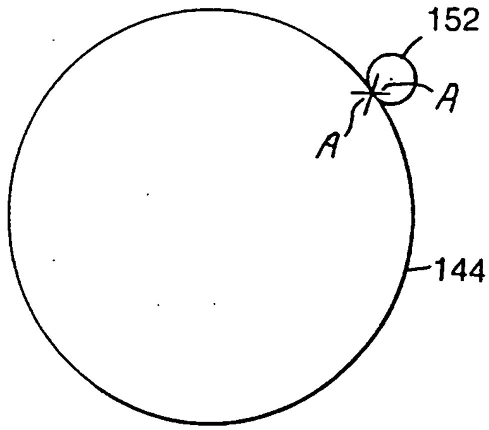


FIG. 11A

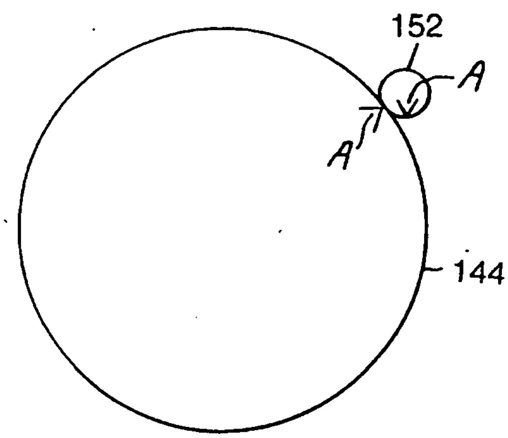


FIG. 11B

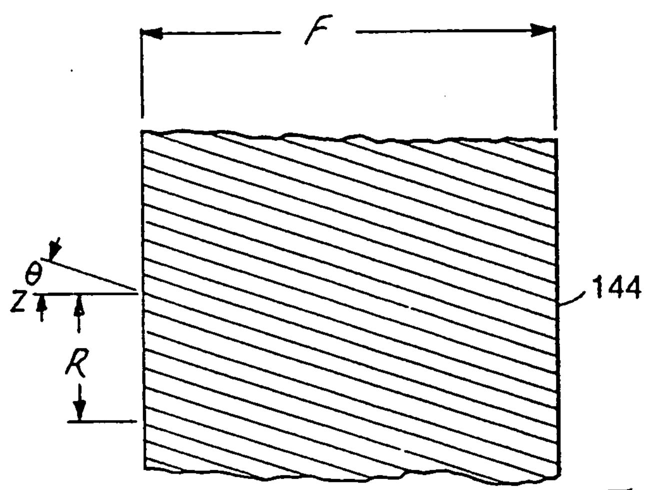


FIG. 12

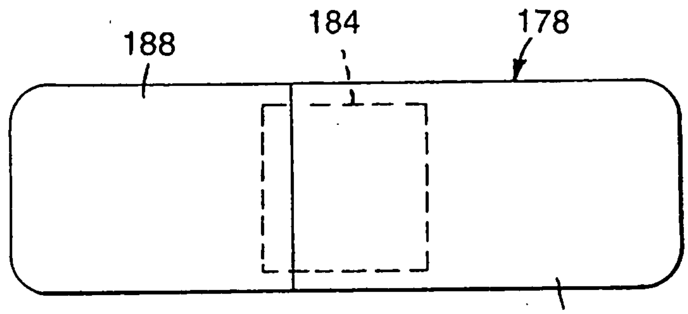


FIG. 13

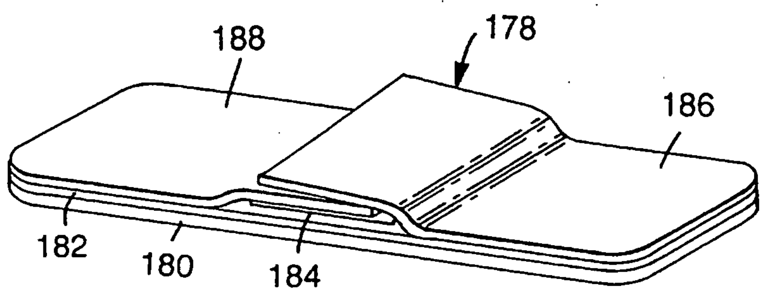


FIG. 14

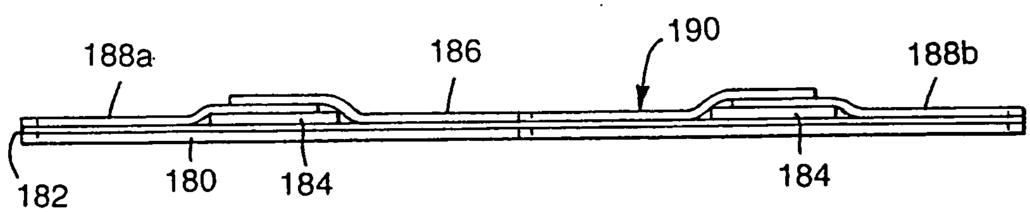


FIG. 15

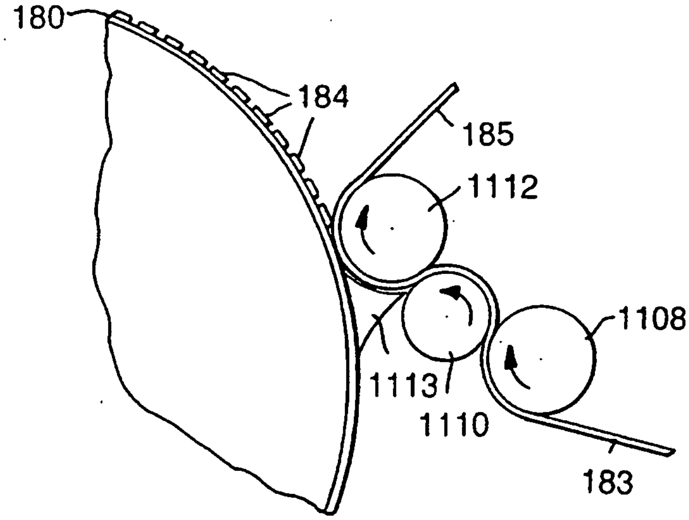


FIG. 17

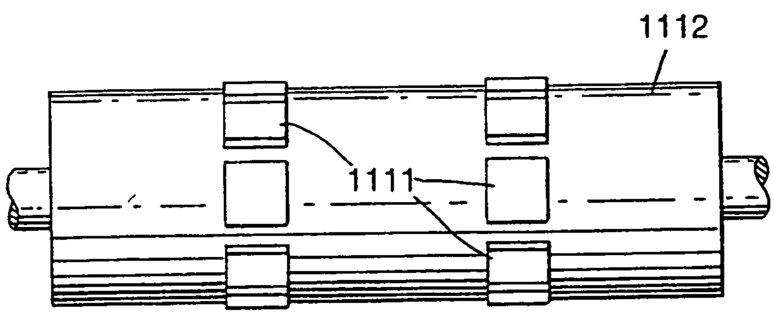
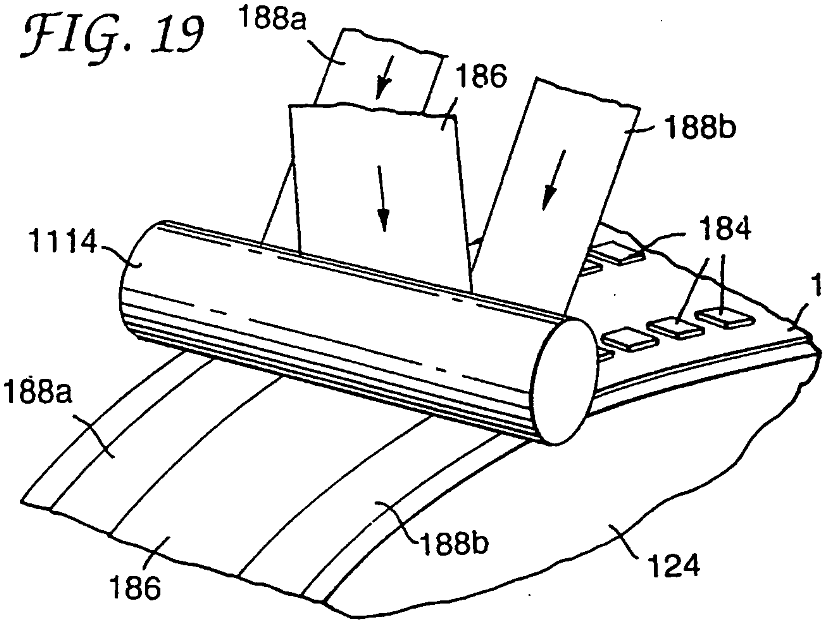


FIG. 18

FIG. 19


188a
186
188b
1114
184
180
188a
188b
186
124

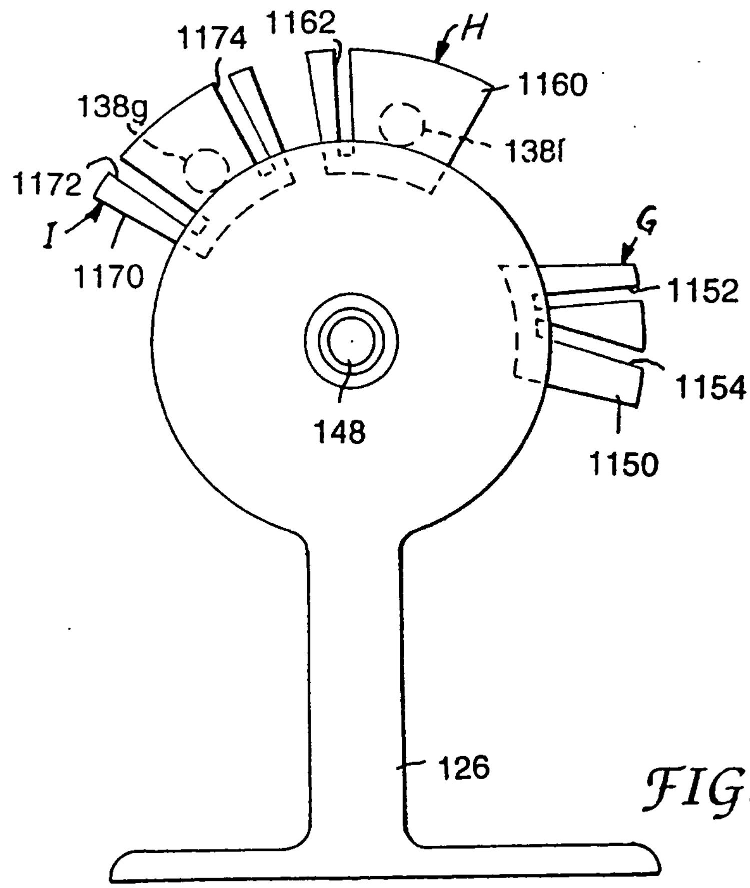

1174
1162
H
1160
138g
138f
1172
I
1170
G
1152
1154
148
1150
126

FIG. 22

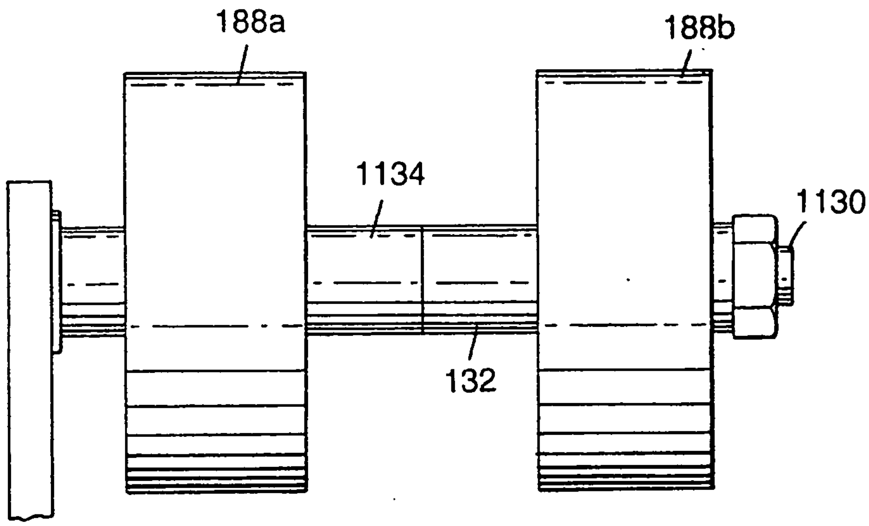


FIG. 20

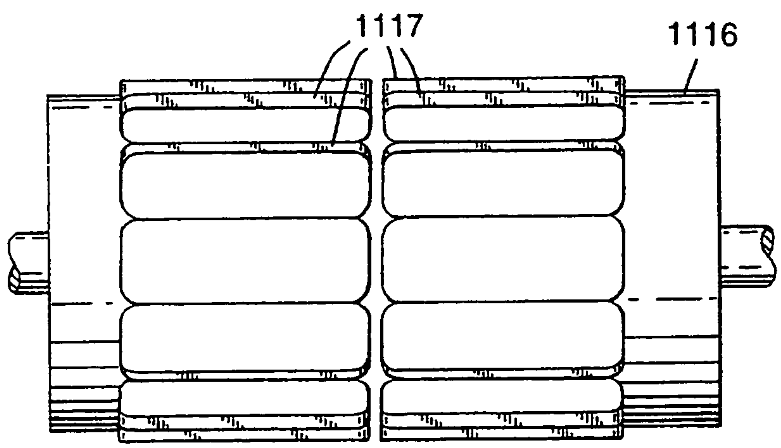


FIG. 21